Langhoff

OCCASIONAL PAPER NO. 77 DECEMBER 1, 1938

SOUTHERN FOREST EXPERIMENT STATION

E. L. Demmon, Director

New Orleans, La.

RESEARCH RESULTS IN SOUTHERN FORESTRY

by

E. L. Demmon, Director
Southern Forest Experiment Station

The Occasional Papers of the Southern Forest Experiment Station present information on current southern forestry problems under investigation at the Station. In some cases these contributions were first presented as addresses to a limited group of people, and as "occasional papers" they can reach a much wider audience. In other cases, they are summaries of investigations prepared especially to give a report of the progress made in a particular field of research. In any case, the statements herein contained should be considered subject to correction or modification as further data are obtained.

RESEARCH RESULTS IN SOUTHERN FORESTRY 1/

by

E. L. Demmon, Director,
Southern Forest Experiment Station

Since 1921, the United States Forest Service has maintained, with headquarters at New Orleans, La., the Southern Forest Experiment Station, one of twelve regional forest research stations in the United States. This Station serves the eight Southern States from Florida and Georgia to Oklahoma and Texas. Its technicians study the problems involved in the protection and management of forests, reforestation, naval stores production, forest economics, relation of forests to erosion and streamflow control, and related subjects. The purposes of these investigations are (1) to determine the basic facts underlying forest production and forest protection in the region; (2) to determine the most effective use of forests in regulating streamflow and controlling erosion; and (3) to bring about the fullest and most profitable use of the 122 million acres of commercial forest land in the deep South.

Also attached to the Station are specialists in allied fields, whose work ties in closely with the Station's program; these include forest pathologists, entomologists, and biologists, assigned by their respective Bureaus of the U. S. Department of Agriculture.

The Station conducts field investigations at a number of experimental forests or outdoor laboratories in various parts of its territory. Since each of these centers of work is typical of forest conditions in its section, the results of these field studies are applicable to a wide area or broad forest type.

Silviculture

Silvicultural studies—those dealing with the science of growing trees—constitute a large part of the Station's activities. They deal largely with the determination of the best way (1) to grow desirable species in the shortest time, (2) to improve the growing forest through thinning young stands and eliminating worthless, undesirable, diseased, and infested trees, and (3) to cut merchantable timber so as to obtain the largest and most valuable yields over an indefinite period of time, i.e., on a sustained-yield basis.

Expanding markets for pulpwood and a steady demand for high-quality sawlogs, poles, piling, and other products, including naval stores, emphasize the widespread need for information on the best and most profitable methods of handling second-growth stands. The stand-improvement problem is important to most of the southern forests, which contain too many trees of little or no value and not enough trees of high value. Recent Station studies show that stand-improvement work to correct or improve this condition frequently can be done at an immediate profit. Many of the poor trees that need to be removed are hardwoods of

---

1/ Address before the Texas Academy of Science, Waco, Texas, November 11, 1938.

no commercial value that can be killed readily by girdling.

That this is a profitable operation is indicated by a stand-improvement experiment in a typical second-growth stand in the shortleaf-loblolly-hardwood type. When this experiment was initiated 5 years ago, 1,200 board feet of pine and hardwood sawlogs, and 3.5 cords of pine pulpwood were removed from the average acre at an immediate profit for this improvement operation alone. In addition, an average of 19 large unmerchantable hardwoods per acre were girdled to benefit the smaller pines beneath them. Cutting and girdling the large unmerchantable hardwoods, as distinguished from the other phases of stand improvement, resulted in an increased growth, in the first 5 years, of about one-half cord of pine pulpwood for each man-hour spent in girdling. At current prices and costs, the hardwood girdling has therefore approximately paid for itself in only 5 years. The pines near the girdled hardwoods will continue to gain rapidly in volume, whereas the pines near the ungirdled hardwoods on the control plot are gaining very slowly, and through mortality, may even decrease in total volume.

Regeneration

The Southern Station territory contains more than 5,000,000 acres of cut-over pine lands, mostly in the longleaf type, on which there is little or no possibility of reestablishing forests by natural means. Research is needed, therefore, to supply the owners and managers of these lands with technical information to enable them successfully to reforest these areas by planting. Research in forest regeneration, which includes studies of seed, nursery practice, and planting, has recently yielded important results in all these fields, three of which will be mentioned here.

1. A simple index to the maturity of cones of the southern pines is important, since the collection of cones too green to open is very wasteful. Such an index has recently been developed by the Station. The specific gravity of a cone was found to be the best index of its maturity, and an easy, practical way to determine whether or not a cone is mature was found to consist in dropping it in ordinary automobile crankcase oil of grade 20, S.A.E. Cones that will float in this oil are mature enough to pick.

2. Another source of considerable waste in seed and nursery practice has been the loss in viability of seeds in storage. Comprehensive studies of the overwinter storage of longleaf pine seed have showed conclusively that low moisture content of the seed and low temperature are necessary for successful storage. Germination percentages of the different seed lots that were tested after storage for $3\frac{1}{2}$ months ranged from 0 to 69 percent. With such large variations, this study alone indicated possible annual savings of about $80,000 in two Southern Forest Service nurseries.

3. In establishing forest plantations, instances of both success and failure are common. A factor that contributes largely to the success or failure of a plantation is the geographic source of the seed. Studies in this field are well under way, and some have already produced very significant results. In a loblolly pine plantation established in 1927 from stock representing four different geographic sources of seed, the best height growth and the least infection with rust canker (Cronartium cerebrum or C. fusiforme) occurred in the trees grown from local seed. The difference in these respects were so striking

after only 10 years in the field that the importance of geographic source of seed cannot be exaggerated.

Naval Stores

Pitch and tar obtained from southern pines were used in Colonial times for waterproofing and caulking wooden sailing vessels—hence the name "naval stores" now applied to turpentine and rosin. For more than a century, the United States has led the world in the production of these commodities. The Station is working out improved methods of obtaining resin or "pine gum" from longleaf and slash pines and of managing timber stands for the production of turpentine and rosin. The purpose is to obtain maximum yields of gum over a long period, at the same time preserving the turpentined trees so that they may be used eventually for lumber or other products. Since the recent lowered demand for naval stores has aggravated the oversupply and prices have reached extremely low levels, lower production costs are very important. The Station consequently is investigating the effect of factors that influence production costs and is aiming to improve methods of extracting gum from the tree.

Early research in naval stores production by the Southern Station disclosed a close relationship between gum yield and the size and growth rate of trees. Gum yields increase with increased size of tree and with increased growth rate. Conservative methods of chipping yield the best results over a long period. Many of the specific practices recommended as a result of the Station's investigations have already been adopted by the industry.

Recent experiments have shown a strong relationship between the grade of rosin obtained and the yield; also between the percentage of scrape (hardened gum adhering to the face of the turpentined tree) and the yield. For timber that yields 20 barrels of turpentine per crop (10,000 faces), scrape makes up 27 percent of the raw material, whereas with "60-barrel" timber, scrape makes up only 14 percent. Furthermore, the gum from the "60-barrel" timber produces a much higher grade of rosin than that from the "20-barrel".

The value of raising cups annually has also been investigated. It was found that on low-yielding timber, cups were raised at an actual loss but that with increased yields the net return from annual raising of cups mounted rapidly.

Mensuration

One objective of research in mensuration is to make available more satisfactory information (a) on the growth and yield of forest trees and stands on various sites and at different ages, and (b) on methods of estimating the volume of standing and felled timber. Another objective deals with the improvement of technique of design and analyses adaptable to the many problems in the field of forest research.

New techniques have been developed for constructing average stand tables and curves of site quality, or site index, based on the inherent variation of average stand heights at different ages. These techniques were developed and used in a study of the growth and yield of second-growth red gum, but the methods are applicable to all species.

Many types of forest research have benefitted from the application of modern analytical technique, involving the randomization of field trials and the method of analysis of variance. As an example of the use of modern analytical technique, the problem of obtaining a reliable forest-nursery inventory by sampling the various beds has recently been worked out. This has resulted in obtaining a reliable inventory that was not expensive but that was sufficiently accurate to aid forest planting organizations in planning their operations. An overestimate of the planting stock results in great waste in moving men to handle the stock, whereas an underestimate may result in excessive mortality of the planted stock because the operations are slowed up and extend too late in the season.

Fundamental Studies

Fundamental studies are concerned with basic physiological and ecological conditions in relation to forest regeneration, growth, and succession. In the South, the study of these relationships as applied to longleaf pine has been of primary importance, since longleaf pine is a highly valuable species but unusually difficult to reproduce satisfactorily. One of the results of recent research in this field has been a determination of the effects of competing vegetation and of density of stocking on the growth of longleaf pine seedlings, which usually remain "in the grass" in a stunted condition for years after the germination of the seed. Five years after the establishment of a study with 12-year-old seedlings averaging only 0.1 foot high, where the density was 1,000 seedlings per acre, seedlings on areas denuded of associated vegetation averaged 9.2 feet high as compared with only 3.3 feet under undisturbed natural conditions. Further research in the laboratory has shown that longleaf pine seedlings grown without grass competition grew twice as fast as similar seedlings grown with grass, all other conditions being the same. These results suggest the possibility of stimulating growth of young longleaf pines by removal of the surrounding vegetation.

A recent study of the soil-moisture requirements of longleaf and slash pine seedlings showed that both species transpire and absorb water at approximately the same rate, and appear capable of surviving both extremely dry and extremely wet conditions. The soil-moisture content for optimum growth of each species is about 25 to 30 percent. The slash pine seedlings, however, require more water than longleaf pine seedlings of the same age to build the same amount of dry matter.

Fire Studies

Of all the factors operating to destroy southern forests, the most serious is fire. Control of fire is essential to the growing of timber crops in the South as in every forest region of the world. The Station's fire studies are directed toward the solution of problems in the development of (a) improved fire-protection methods; (b) a method of evaluating the effects of fire; and (c) a technique of controlled burning that is both economical and effective. Past work was directed principally to learning the effects of fire and the benefits of fire protection. More recently the Station has been concentrating its efforts on analyzing forest-fire danger and protection needs under varying conditions. Fire danger, as it concerns both the probability of a fire starting and the difficulty of suppressing a fire once started, changes greatly from day to day and even from hour to hour. Maintaining too large a fire-suppression organization is extremely costly, while too small an organization during severe fire conditions may be

disastrous. Intensive studies of 300 fires have revealed a close relationship between the rate at which fires spread and the weather and fuel conditions. From these relationships, it has been possible to estimate the size and rate of spread of a fire at any given time under varying conditions of wind velocity, fuel moisture, and age and density of the ground vegetation. For estimating fuel moisture, a special hazard-indicator stick has been developed. Usually a measure of the wind velocity and the fuel moisture is sufficient to predict the size and rate of spread of a fire on any particular forest. Determinations are also being made of the rate at which fires can be extinguished under these same conditions. The relation of probability of fire occurrence to burning conditions has also been studied. The results are being used to provide a basis for planning fire-protection organization and for estimating the size of crew needed on specific fires. As a result, real savings will be possible through reducing the size of fire-fighting organizations during periods when burning conditions are poor. Extra safety is also provided through specified expansion when severe conditions are indicated.

Studies of Forest Influences

In many parts of the South, improper land use has permitted abnormal washing or erosion of sloping lands by rainfall and has transformed hundreds of thousands of acres of what was once fertile agricultural land into eroding wastes, the productive capacity of which has been greatly impaired and in some places destroyed. Rapid run-off of rain water also adds materially to flood problems and constitutes a serious menace to property in many lowland areas. Because of these problems, emphasis in the Station's program of forest-influences research has been placed on developing simple, effective methods of restoring a forest cover on eroded lands, to provide a practicable means of controlling water run-off and conserving soil. Other investigations have dealt with basic factors affecting run-off and associated soil-erosion problems.

In a study of soil and water losses from seven types of cover and land use, representative of the Loessal and upper Coastal Plain regions in northern Mississippi, it was found that barren or cultivated lands lose 4,300 times as much soil as lands protected by forest or grass cover, which absorb practically all the rainfall. In another study in which forest litter was applied to the surface of a compact, eroded subsoil, erosion decreased to negligible proportions, and surface run-off was reduced more than 50 percent. Other studies have demonstrated that annual light surface fires markedly increase surface run-off and erosion from forest and grass land.

One of the main contributions from the Station has been the development of simple techniques for controlling erosion. Station studies have served as a guide to large-scale erosion-control projects demonstrating that trees and other soil-binding plants can be established successfully on gullied lands, using inexpensive check dams and other simple site-improvement measures. For successful planting of impoverished, eroded sites, the Station has found: (1) that top-grade seedlings must be used; (2) that southern pines can be established satisfactorily by planting the trees in holes filled with topsoil, thus dispensing with check dams, bank reduction, and other more expensive preparatory measures; (3) that it is desirable to plow or remove heavy grass before planting black locust, but that similar treatments are unnecessary for shortleaf or loblolly pine; (4) that losses of broadleaf planting stock can be prevented by heeling-in the trees in sand in-

stead of loam; (5) that it is possible to plant rather large black locust stock at little additional expense by drastically pruning the roots. Another Station study has resulted in the development of a cheap, effective seed treatment for black locust, viz., soaking in concentrated sulphuric acid, which in field trials doubled the yields of seedlings.

The control of erosion on roadbanks constitutes a serious problem in the Southern Region and usually requires rather costly remedies. Station studies have shown that eroding cutbanks can be stabilized successfully without reducing them to gentle gradients and without resorting to the more costly sodding methods in everyday use. A special method of preparing and planting banks has been developed that gives greatly superior results to those obtained from the usual method of contour trench planting. This study has shown: (1) that relatively wide spacing of small Bermuda-grass sods or broadcast sowing to seed of several herbaceous species can be relied upon to provide a satisfactory plant cover; (2) that cutbanks should be planted in the spring rather than in the fall, but that sloping and other preparatory work on the banks should be done preferably in the fall; (3) that light top dressing of fertile soil is a minimum requirement in stabilizing cutbanks; and (4) that light applications of fertilizer are also helpful.

Private Forestry Investigations

Ninety-three percent of the commercial forest land and 95 percent of the saw-timber volume in the Station territory are in private ownership. Of this privately owned forest land, over 37 percent is on farms. According to the last Census figures, the forest industries of the South provide employment for about one-fourth of all persons employed in manufacturing industries. Under proper protection and management, the yields from these forest lands could be increased greatly and could support more than 2,000,000 people on a stable and permanent basis. These figures indicate the importance of the private-forestry problem in the South. In fact, the economic and social future of the South is dependent to a very large degree on the productivity of these lands.

To encourage private owners to adopt sustained-yield forest management, the Southern Station is obtaining definite information on costs and returns of timber growing. Through production cost studies and financial analysis, it is developing improved methods of managing and utilizing Southern forests. At present, these studies are centered at Crossett, Arkansas, in the shortleaf-loblolly pine type. One of these studies has shown the economic feasibility of light selective cuttings in virgin pine stands, using railroad logging. Somewhat less than half the saw-timber volume was cut, while about two-thirds of the number of trees of saw-timber size, including the most thrifty individuals, were reserved for future cuts, using 10-year cutting cycles.

Most of the timber in the South, however, is second-growth, and the per-acre volumes of saw timber are too light to make railroad logging profitable. Studies were made, therefore, of selective logging with trucks and with tractors. These showed that cuts as light as 500 board feet per acre are financially feasible, and that costs of logging were much less, and the net return per M board feet much greater for large trees than for small ones. It was also found that the top logs of second-growth trees could be cut more profitably into pulpwood than into sawlogs. The method of selective-timber management with light cuts at 5- to 10-year intervals, as developed by the Station has been adopted

successfully by a large number of operators.

New Public Domain

The causes and uses of the South's "new public domain"—the area that has been forfeited to public ownership for non-payment of taxes—are also being studied. In 1934, approximately 31 million acres was found to be in tax-default for 3 or more years; about 17 million acres of this was forest land, or about 14 percent of all the forest land in this region. Station studies indicate that this extensive tax-delinquency of forest land is, in general, the result of one or more of the following: (1) overcutting of the timber resources and subsequent abandonment of the property; (2) poor administration of the tax system; and (3) inequitable taxes.

The remedies lie in improving conditions for private forest operations, placing them on a permanent basis, improving the administration of tax laws, and, where necessary, revising the laws. For lands that no longer can support private operations, the obvious solution is public ownership.

Forest Survey

The Forest Survey of the South was started in 1930. It includes an inventory of the present supplies of standing timber and other forest products, a determination of the rate at which the timber is being increased through growth and diminished through industrial and other uses, and a study of future forest requirements. Its purpose is to supply information needed to formulate a regional policy for the effective and rational use of land suitable for forest production. Field work has now been completed on all except the post oak and cedar-brake regions of Texas and Oklahoma, and computation, interpretation, and publication of results are well under way.

Of 208 million acres of land in the deep South already surveyed, it was found that 122 million acres, or nearly 60 percent of the total area, is forest land. Pines make up about 45 percent of the total cubic volume of sound trees, while hardwoods and cypress comprise the remaining 55 percent.

For four sub-regions of the South, the average saw-timber stand per acre for all conditions from clear-cut to old growth was found to be as follows: pine-hardwood region west of the Mississippi River 2,530 board feet; pine-hardwood region east of the Mississippi River 2,340 board feet; naval stores region 1,500 board feet; and Mississippi Delta region 2,530 board feet.

An enumeration of the sawmills in the deep South showed that there were 8,205 known mills more or less active in 1936. Of these, 7,565, or more than 92 percent, were small mills with a capacity under 20 M board feet per day. Large mills are gradually decreasing in number, and small mills are becoming increasingly important in lumber production. In 1934, small mills produced 47 percent of the pine lumber cut.

The rapid expansion of the pulp and paper industry in the South has nearly doubled the capacity of its pulp mills since 1935. Another step in this expansion is proposed in east Texas, where plans are being made to erect a mill to make newsprint from southern pine—the first mill of its kind in the South. Most

of the southern pine pulp mills operate by the sulphate process, which makes paper for bags, wrappers, and container boards. A few mills, including the one at Houston, Texas, make bleached sulphate pulp, which goes into white paper.

The relationship between forest growth and drain is constantly changing, as is illustrated by data for northeast Texas. At the beginning of 1935, this survey unit of 8½ million acres had approximately 1,740,000,000 cubic feet of pine growing stock. During 1935 and 1936, the increment slightly exceeded the drain, so that by the first of 1937 the growing stock had increased about 20,000,000 cubic feet. During this same period, however, the drain also increased and for 1937 exceeded the growth by about 3,500,000 cubic feet. Such fluctuations in the cut of forest products emphasize the need for keeping this information up to date. In 1935, in the southeast Texas survey unit covering nearly 10 million acres, there was an increment of about 303,000,000 cubic feet for all species, or slightly more than double the drain for all purposes.

The east Texas post oak belt—a region of about 12,000,000 acres lying between the east Texas pine belt and the "black prairie" country—has a forest area of about 3,600,000 acres, constituting 29 percent of the total land area. Approximately 93 percent of this forest is in the post oak type, which is chiefly of local value for cordwood and other domestic farm uses. Four percent is in hardwood types, which produce material of commercial saw-timber quality; these types occur in the river bottoms and on some of the better upland soils. The remaining 3 percent is in pine and cedar.

Summary

In this paper, I have summarized a few of the results of research conducted by the Southern Forest Experiment Station. We all recognize the desirability of promoting the full use of the immense area of forest land in this southern region, most of which is now utilized but partially. The findings of the Southern Station are made available currently to interested agencies throughout the South, which in turn disseminate the information to forest landowners. Progress reports are made public by the Station in "Occasional Papers", "Survey Releases", and technical journals, whereas final reports are printed in Washington. The application of the methods recommended by the Station, which must be made by the landowners and managers themselves, should result in a more diversified use of the forests, more permanent communities and industries, a more permanent employment of labor, more prosperous railroads and other utilities, a broader and more stable tax base, and a better standard of living for the people of the South. In the meantime, the program of the Southern Station will continue to be directed towards helping the South attain the full opportunities offered by its most valuable natural resource—its forests.